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Groundwater and Climate Change

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Presented by Ashley Thompson, Geography 490

What is groundwater?

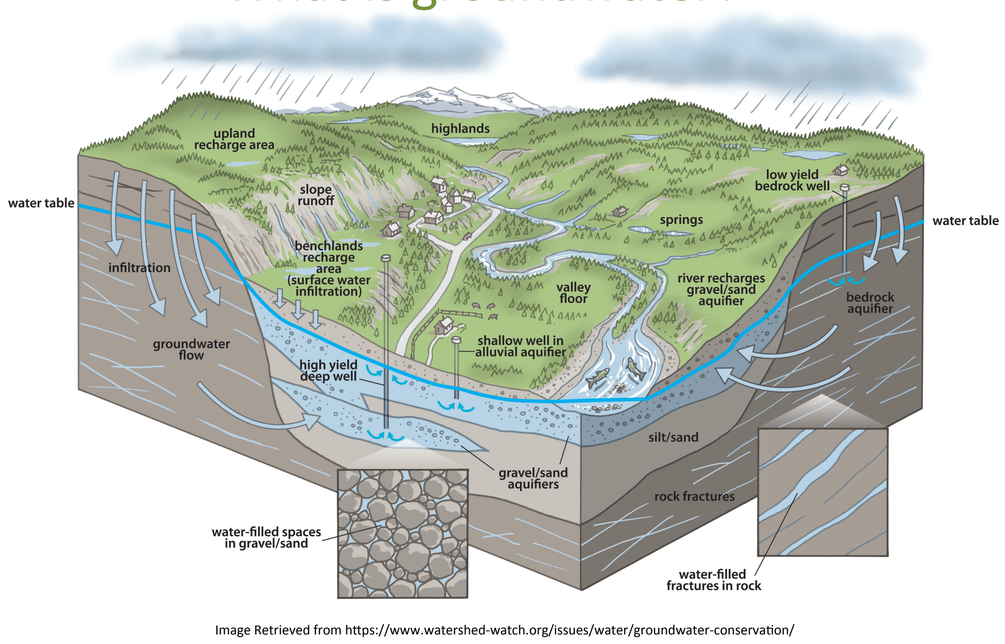


Image Retrieved from https://www.watershed-watch.org/issues/water/groundwater-conservation/

- Water stored subsurface in aquifers
- Aquifers: water saturated zones of sediment and fractured bedrock
- Groundwater is an important source of freshwater, globally accounting for[1]:
    - 42% of irrigation water
    - 36% of domestic water
    - 27% of water for industrial use
- In stable aquifers, the amount of **recharge** equals the amount of **discharge** and **withdrawals**
    - Recharge: water entering an aquifer, usually by precipitation runoff seeping down through the ground or seepage from surface bodies of water, such as rivers or lakes
    - Discharge: water exiting an aquifer, by entering surface bodies of water or through withdrawals, when people dig wells or pump water out

What is climate change?

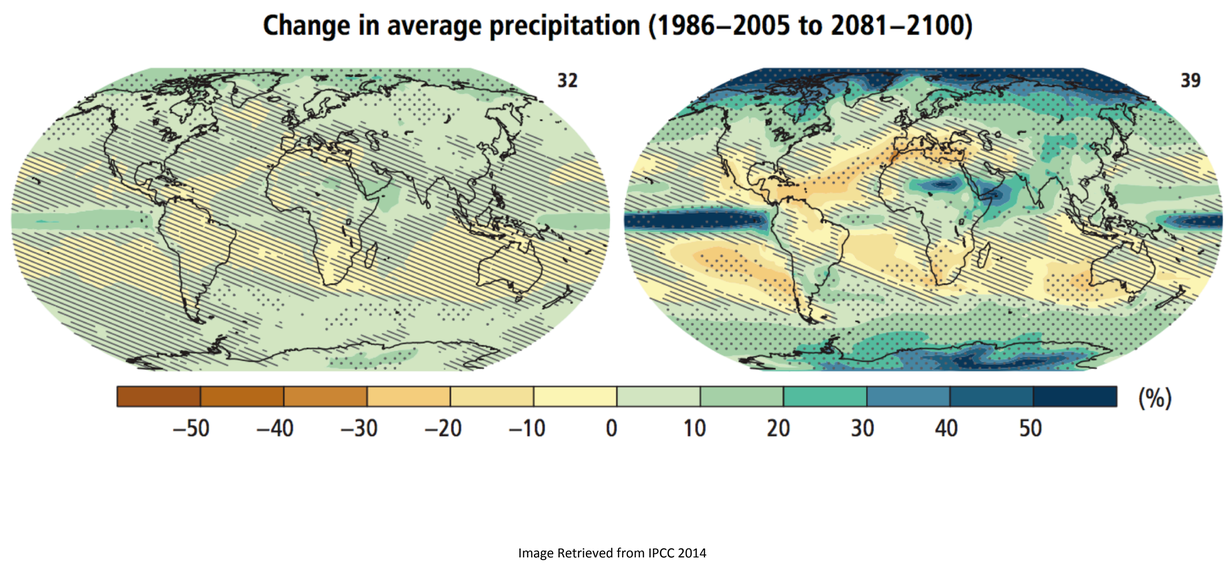
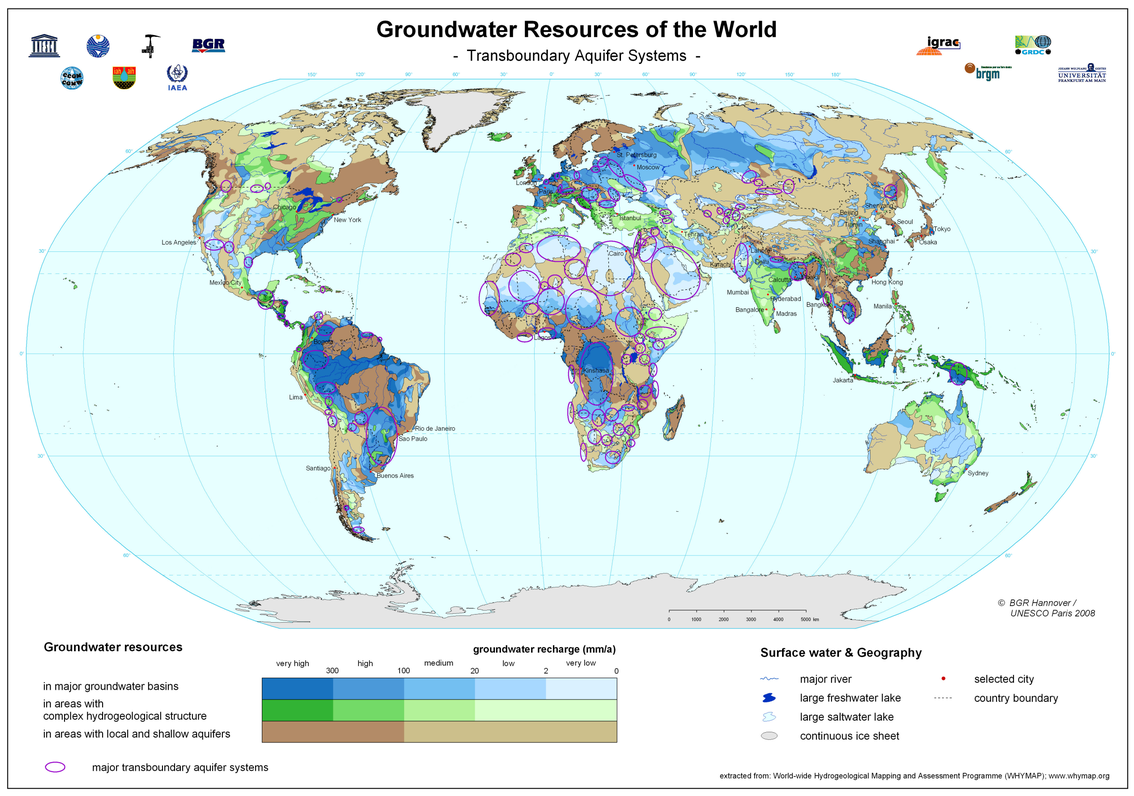


Image Retrieved from IPCC 2014

- By 2100, global temperature will rise by 0.3 to 4.8 °C due to increased carbon dioxide in the atmosphere from the combustion of fossil fuels[2]
    - Record high temperatures will be more likely than lows
- Precipitation patterns will vary by region[2] (see figure above)
    - Average increase: Tropics, mid-latitude regions that are generally wet, and high latitudes
    - Average decrease: Subtropics and mid-latitude regions that are generally dry
- Precipitation extremes, such as drought and intense rainfall events, are expected to occur more frequently and for longer periods of time[1]
- Sea level rise will occur by:
    - Thermal expansion: water expands when temperature increases
    - Melting of glaciers and ice sheets



Climate-Groundwater Relationship

For recharge to occur, the amount of precipitation must be greater than the amount of evaporation and transpiration[1]

- Decreases in precipitation will decrease recharge
- Increases in precipitation can increase recharge
    - Consider vegetation responses:
        - Greater precipitation can cause vegetation growth, losing water to transpiration and decreasing recharge[1]
        - Higher levels of carbon dioxide in the atmosphere can cause the stomata of leaves to shrink, decreasing transpiration and increasing recharge[3]
- Higher temperatures can cause more evaporation, potentially decreasing recharge
- Over time, loss of glaciers will decrease recharge[1]
- Sea-level rise can cause salt-water intrusions of coastal aquifers[1]
- Warming increases frequency of storms, in turn increasing storm surges which can also cause salt-water intrusions of coastal aquifers[1]

Humans, Climate Change, and Groundwater

- Irrigation water sourced from groundwater, especially in times of drought, causes groundwater depletion[4]
    - Irrigation demand is expected to rise globally
- Irrigation water sourced from surface water can increase recharge via runoff[4]
    - Aquifers recharged by agricultural runoff can experience salinity increases as well as buildup of nitrates[1]
- Salt-water intrusions into coastal aquifers are exacerbated when coastal aquifers have experienced major withdrawals[1]

References

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2. IPCC (2014). *Climate change 2014 synthesis report: Summary for policymakers.* Retrieved from https://www.ipcc.ch/pdf/assessment-report/ar5/syr_AR5_SYR_FINAL_SPM.pdf
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4. Leng, G., Hunag, M., Tang, Q., & Leung, L. R. (2015). A modeling study of irrigation effects on global surface water and groundwater resources under a changing climate. *Journal of Advances in Modeling Earth Systems, 7*(3), 1285-1304. doi:10.1002/2015MS000437